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THE

TEA QUARTERLY

THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

Edited by

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THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle.

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NOTE.

The Laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address :—Research, Talawakelle; Telephone, Talawakelle 44 (Private Exchange). It is particularly requested that letters should not be addressed to officers by name.

EDITORIAL

TEA RESEARCH INSTITUTE CONFERENCE

The Institute's Sixth Conference will be held on the 13th and 14th February, 1939. In previous years the proceedings on both days have been at St. Coombs. On the present occasion it has been decided, however, to hold the discussions on the first day at the Dimbula Athletic and Cricket Club, Radella, which has kindly been placed at the disposal of the Institute by the President and Committee. This arrangement should provide more comfortable accommodation for a larger number of visitors, and possibly the less formal surroundings may lead to a greater disposition to join in the various discussions.

On the second day, February 14th., the Director and Staff of the Institute will welcome visitors to St. Coombs Estate and Factory and the Institute's Laboratories when members of the Staff will explain work in progress in their sections and there will also be demonstrations or discussions in the different laboratories.

A programme of both days' proceedings has already been distributed and is reprinted below. It is hoped that the discussion on Soil Management to be held on the morning of the first day may be opened by Sir E. J. Russell, F.R.S., the Director of the Rothamsted Laboratories who will be attending the Conference.

A word of explanation is perhaps necessary in regard to the items "General Discussion" included at the end of both the morning and afternoon sessions on the 13th. There will of course be discussions after each paper, but it is felt that there are probably many subjects not covered by the items in the programme concerning which visitors may wish to obtain or impart information and time has therefore been allowed for such questions to be raised. It would be a convenience if visitors could give previous notice of such questions, and the staff will welcome any suggestions which intending visitors may like to make in regard to subjects for this part of the programme.

To facilitate discussion on the other items in the programme abstracts of the papers to be read will be issued before the date of the Conference to all those who have intimated their intention of

being present. Visitors will have time to read these summaries before the meeting and should therefore be in a better position to discuss the issues raised.

Lunches and teas will be obtainable at Radella Club on the 13th, and a limited number of meals at St. Coombs on the 14th. Arrangements will be much facilitated if those intending to be present and needing meals will inform the Director as soon as possible of their requirements. A slip for this purpose will be found attached to the programme already issued.

Through the co-operation of the Dimbula District Planters' Association it is hoped a limited number of billets may be available in the district for those coming from a distance. Early application for such accommodation is essential.

PROGRAMME

FIRST DAY. Monday, February 13th, at RADELLA CLUB.

MORNING SESSION 9-45 A.M. TO 12-15 P.M.

9-45 A.M.	...	Opening of the Conference by the Chairman.
9-55 A.M.	...	"The Work of the Institute"—The Director.
10-20 A.M.	...	Discussion on Soil Management. It is hoped this will be opened by Sir E. J. Russell, F.R.S., Director of the Rothamsted Laboratories. This will be followed by a paper on "Cultivation" by Dr. T. Eden.
11-20 A.M.	...	"The Improvement of Planting Material"—Dr. F. R. Tubbs.
12 NOON	...	General Discussion.

LUNCH

AFTERNOON SESSION 2 TO 4 P.M.

2-00 P.M.	...	Discussion on Manufacture. (*a*) The Director—"Manufacturing Problems." (*b*) Mr. D. W. Finley—"Heat in Relation to Manufacturing Processes."
3-00 P.M.	...	"Disease in Non-Productive Bushes"—Dr. C. H. Gadd.
3-20 P.M.	...	"Tortrix Control"—Mr. C. B. Redman King.
3-40 P.M.	...	General Discussion.

SECOND DAY. Tuesday, February 14th, at ST. COOMBS.

The Laboratories, Factory and Estate will be open to visitors from 8-30 a.m. to 12 noon, and from 2 to 4 p.m.

Members of the Staff will explain the work in progress in their sections. There will also be demonstrations or discussions as follows :—

9-00 A.M.	...	*Mycological Division.* Demonstration of the Diagnosis of *Phloem necrosis* and Methods used in Investigating its Cause.
9-45 A.M.	...	*Physiological Division.* Discussion on Seed-Bearers.
10-30 A.M.	...	*Chemical Division.* Demonstration of Cultivation, Soil Resistance and Root Investigation Methods.
11-00 A.M.	...	*Entomological Division.* Demonstration of Pest Control Measures.
11-30 A.M.	...	*Physiological Division.* Demonstration of Selection and Propagation Methods.

GUEST HOUSE

A small Guest House has now been built on St. Coombs and will, it is hoped, be ready for occupation early in February. Sleeping accommodation will be available for five persons in two double and one single rooms.

The following rules for the use of the Guest House have been approved by the Board:—

(1). The Guest House is normally intended for the use of persons visiting the Institute and St. Coombs Estate on business. Children can in no circumstances be accommodated.

(2). Permission to occupy a room for the night must be obtained from the Director in writing and, unless sufficient notice be given, accommodation cannot be guaranteed.

Two double rooms are available for the use of visitors accompanied by their wives.

(3). All visitors must sign the Visitors' Book on arrival.

(4). A bed room may not be occupied for more than one night if required by another visitor. This shall not apply to members of the Board or of Committees meeting at

St. Coombs who shall also be entitled to priority in the allocation of accommodation when on official business.

(5). Complaints or suggestions must be entered in the book provided for the purpose and not made to the Guest House Staff.

(6). All payments due for services rendered shall be made in *cash* to the steward-in-charge and a receipt obtained from him on the official form. The scale of approved charges is posted in the building. The steward is forbidden to give credit or to accept cheques.

(7). Liquor is supplied for consumption *in the premises only*.

(8). The Institute accepts no responsibility for cash, jewellery or other valuables of any kind left in the Guest House.

(9). All breakages will be charged for at cost price.

APPENDIX

Charges.	Rs. cts.
Occupation fee by day without use of bedroom ...	25
Occupation fee by day with use of bedroom and bath	75
Occupation of bedroom per night per person ...	2.50
Early tea	25
Breakfast: bread, butter, bacon and eggs, tea ...	1.25
Lunch: fish or eggs, meat course, pudding or cheese	1.50
Afternoon tea: tea, bread and butter, jam ...	50
Dinner. Three courses.	2.00

(Other meals at scheduled rates)

Garage.—50 cents per car per 24 hours in lock-up garage.

As supplies are not available at short notice persons requiring meals are asked, if possible, to give previous warning.

ROLAND V. NORRIS,
Director.

THE MANURING OF TEA*

T. EDEN

In a small book on soils which I reviewed in the last number of *The Tea Quarterly* the author stressed the view that the agricultural problem of plant nutrition will only be satisfactorily solved when the physiology of the plant is completely known. This is unfortunately only too true, and though, as I pointed out in the review in question, we cannot wait till all this detailed knowledge is available before coming to grips with the problem of manuring of crops, such a declaration serves to remind us that the plant is the most important factor in the partnership of plant, manure and soil. Too often we are apt to think and speak of manuring the soil and not of feeding the plant. So today in speaking to you of tea manuring it is the plant relationship that I shall emphasize and you will hear little about manurial recipes for this or that type of soil.

MANURING IN RELATION TO GROWTH STAGE OF THE PLANT

It is common knowledge that the plant obtains its mineral foodstuffs such as potassium; its phosphorus and its nitrogen from the soil by means of its root; and that its carbonaceous tissues are built up from carbon dioxide abstracted by the leaves from the atmosphere. How these two streams of food supply are combined is still largely a mystery, but, from the combination of the two, substances are produced which repair the wastage of tissues, provide for storage, stimulate growth, and bring about all the complex changes that occur in the normal life time of a plant. Now I neither can nor intend to delve into the difficulties of the plant's mechanism for doing all these things, but in the few sentences I have already used there have occurred three words involving three important conceptions, time, storage, growth.

It is obvious that in any attempt to rationalise manuring of a crop we shall have to take into account these factors. Let me put a few questions: Does it matter when we manure the tea bush? If we supply more food than the bush can use immediately, can it store it up for use in the future? To what extent can we make a bush grow when, to speak colloquially, it does not want to? Does there

* An address given before the Southern Province Planters' Association on December 3rd, 1938, at Galle.

come a time when a bush does not take up any more foodstuffs? Does a bush require a change of diet and of quantity of food at different stages in its growth? These are the kind of questions which to my mind lie at the root of successful manurial practice and not the questions relating to the alternative use of sulphate of ammonia and blood meal; mineral phosphate or superphosphate.

To some of these questions I can give no answer at all, to some I can only give a partial or a tentative answer, but the experimental work done by the Institute has to an appreciable extent brought order out of chaos and since manurial recipes are still a mystery to some, I am going to play the part of the conjurer who shows how his tricks are done.

There are some crops which only take up nitrogen during particular phases of growth. For example, the barely plant growing for fifteen weeks between seed time and harvest attains its maximum store of nitrogen by the end of the tenth week. Thereafter it merely moves the nitrogen it has garnered from one place to another; from leaf to maturing grain. Our evidence for tea is necessarily incomplete, but there is no evidence to hand that such phasal growth occurs in tea where of course the attainment of a reproductive phase giving flower and seed is sedulously avoided. That is not the same thing as saying that there are not occasions when nutrient uptake rates differ widely but such periods are more directly linked to the climatic conditions than to something intrinsic in the plant.

YIELD RESPONSE TO NITROGEN

The fact that manuring has been so widely successful under all sorts of conditions confirms us in the view that up to a certain limited capacity the bush will utilize manure during the greater part of its life. Of course one can imagine a condition when the bush is so large that other environmental factors, *e.g.*, light and water become limiting, but on the average tea estate in Ceylon that stage is not found. Nor are the quantities usually applied so great that the bush cannot deal with them. If all the nitrogenous manures that are imported into Ceylon were used exclusively on tea and were strictly rationed, no tea estate would receive more than 30 lb. of nitrogen per acre. The Tea Research Institute has so far experimented with doses as high as 80 lb. per acre and so far the response is fully proportional to the dose. The highest dose has only been given during the last two years to tea which previously had 40 lb. of nitrogen per acre, and it may be that when this 80 lb. has had its full effect over a period of years, the bushes will have developed to a stage where the limiting conditions of light and water, to which

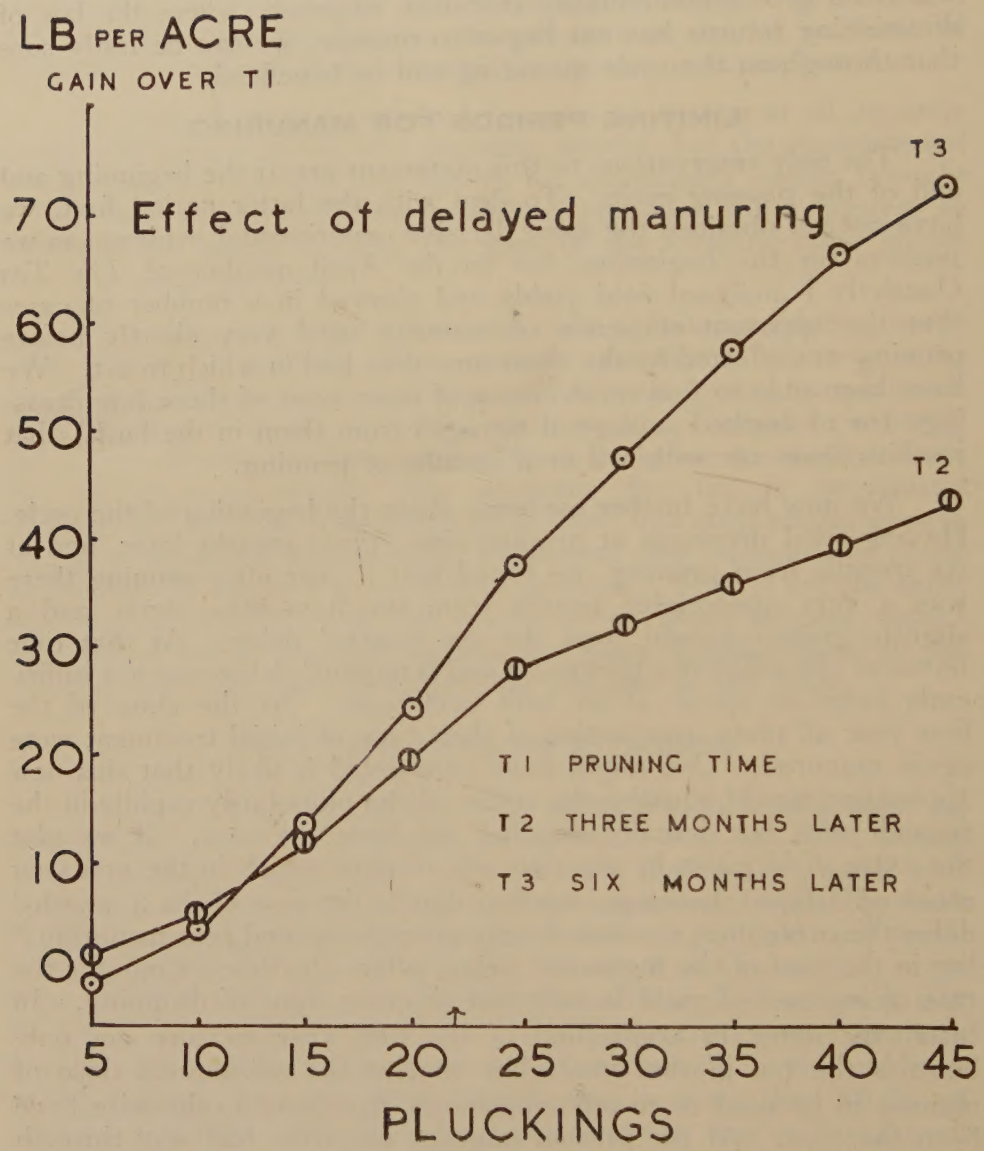
I referred, become operative; when therefore it will be possible to *maintain* the crop on reduced rations, but that time has not yet arrived. Because therefore we are using doses well beneath those which do give a continuously economic response, where the law of diminishing returns has not begun to operate, we can be fairly sure that throughout the cycle manuring will be beneficial.

LIMITING PERIODS FOR MANURING

The only reservations to this statement are at the beginning and end of the pruning cycle. To deal with the latter period first, we have not yet obtained the same decisive experimental evidence as we possess for the beginning, but in the April number of *The Tea Quarterly* I analysed field yields and showed in a number of cases that the apparent efficiency of manures used very shortly before pruning was affected by the short time they had in which to act. We have been able to find no evidence of carry-over of these late dressings (or of marked storage of nitrogen from them in the bush) that justifies their use within 2 or 3 months of pruning.

We now have further evidence about the beginning of the cycle. Having tried dressings at pruning time, three months later, and at six months from pruning, we found that a year after pruning there was a very appreciable benefit from the 3 months' delay and a slightly greater benefit from the six months' delay. At that time however the difference between 3 and 6 months' delay was not sufficiently large to speak about with confidence. At the close of the first year all plots irrespective of their time of initial treatment were again manured. One might have considered it likely that this new application would equalise the status of the plots fairly rapidly in the second year, but actually this has not been the case. If we plot the extra yield given by the two sets of plots which in the first year received delayed dressings, we find that in the case of the 3 months' delay the curve does rise less steeply after the second year manuring,* but in the case of the 6 months' delay, after a further six months the rate of increase of yield is only just showing signs of dropping. In brief, the delay in application of the first year mixture not only benefits the tea in that year, but enables the subsequent dose of manure to be used more advantageously than would otherwise have been the case. At the present moment just over half way through the pruning cycle the maximum benefit from the delayed manuring amounts to 72 lb. per acre, using of course, exactly the same amounts of manure in both cases. As I have explained in previous lectures the lack of effect of manures applied at pruning time in the very early stages of the cycle is due to the fact that nothing like full

* Marked with an arrowhead in the diagram on the time scale of pluckings.


LB PER ACRE
GAIN OVER T1
Effect of delayed manuring
T3
T2
70
60
50
40
30
20
10
0
T1 PRUNING TIME
T2 THREE MONTHS LATER
T3 SIX MONTHS LATER
5
10
15
20
25
30
35
40
45
PLUCKINGS

efficiency is achieved by the plant until it has a crown of foliage that makes it self-supporting in those nutrient constituents that come not from the soil but from the air. The present data show that once that efficiency is attained the increasing root, shoot and leaf expansion makes nutrient consumption and use extremely favourable.

So far then we have found by our experimental work that there is a period at the beginning of each pruning cycle when the bush develops solely from its stored food reserves. This is followed by a period of rapid expansion and of nutrient activity, and the question as to whether that activity becomes more sluggish as the cycle proceeds still remains to be settled. We know that in many instances the yield drops toward the end of the cycle. We have still to determine whether the capacity to use manures drops too, or whether the decline is due to entirely other causes. At present the indications are that instead of a flat rate of manuring throughout the cycle, starting with the time of pruning, we shall be better served by a gradually increasing supply up to the later manuring, *i.e.*, when the bush is not increasing its flushing points. The initial dose would be delayed till that period of the cycle when the plant becomes self-supporting in carbohydrate synthesis. For low-country conditions with fringe pruning or high cut-across that point will be much nearer pruning time than up-country. I define the correct itme as tipping time.

ADVISORY METHODS

So far I have dealt with what I consider to be the most important aspect of manuring — its relation to the growth and development of the plant. I propose to end my lecture by indicating how I tackle the business of advisory work on manuring. In a district with which I am not thoroughly familiar, I frequently visit the estate in question. This not only gives me a chance of examining the records and abstracing information likely to be helpful, and discussing matters with the superintendent; it also makes it easier to tell whether the fault (if any) is really due to inadequate or irrational manuring, or is attributable to some other cause. As regards the manure mixtures used, I alter these only when they are positively wasteful or more expensive than circumstances justify, or when they are obviously not capable of maintaining the crop in good production. Monthly yields per field arranged by pruning cycles are the most valuable data I can examine, much more so than the average annual yield per acre. From cycle yields it is possible with experience to assess the value that is being obtained from the manuring, and to choose a manuring interval that will best suit the purpose. Having settled this, a single suitable mixture is prescribed. The question as to what is a suitable mixture requires some definition.

First let us consider the nitrogenous constituent. If a sufficient yield is being steadily obtained on a given quantity of nitrogen, then that quantity can be taken as standard, unless it can be shown that some portion of it is wastefully used under the existing scheme. Using that quantity per annum as a datum line, the quantities at each application are calculated, at present quite empirically, with a gradual increase governed by age from pruning till the last or last but one according to the information revealed by the cycle yield curves: the average remains that previously decided. I admit that this method has not yet been reduced to a stage of complete experimental verification but it has a solid rational basis behind it, and experience over some years now shows that it works.

The phosphoric acid and potash are applied *pro rata* and their standard rates are determined by separate considerations. For crops of normal size, (*i.e.*, 500-900 lb. per acre) experiments show that though 30 lb. of phosphoric acid gives a measurable response, a higher dose (60 lb. per acre) does not. I have therefore taken 30 lb. as a standard dose. The truly economic figure may be below this: I hope to test that later, but it is demonstrably not higher than 30 lb.

In the case of potash we have recorded over a period of 8 years no *crop* response to potash. We have discovered small but definite differences in the chemical composition of the foliage of the plant which may or may not be precursors of something more important. Brokers have tended to prefer very slightly the teas manured with potash. We cannot therefore dismiss potash because it gives no obvious and directly tangible results. We know that a quantity of potash is continually and permanently removed from the soil in the form of crop and pruning wood. It is therefore our aim to replace this in full and to safeguard ourselves by erring on the side of generosity. Two point five pounds of potash per 100 lb. of harvested tea is the lower limit.

Such a conception as I have put before you gives a programme which I can illustrate by an actual example. An estate with a two-year cycle was receiving a mixture of the following composition once in a cycle of 2 years at pruning time:—

Groundnut cake	...	60 lb.
Crushed fish	...	170 ,,
Sulphate of ammonia	...	80 ,,
Saphos ...	...	50 ,,
Muriate of potash	...	40 ,,
	Total	400 lb.

thus giving approximately 27.5 lb. of nitrogen, 21.5 lb. of phosphoric acid, and 20 lb. of potash. Cost was in this case a consideration, so that it was obvious that two points needed adjustment:—

(1). The type of mitxure (the prescription being expensive in its type of nitrogen).

(2). Time of application (which was wasteful).

The following mixture was substituted:—

Castor cake	...	20 lb.
Sulphate of ammonia	...	130 ,,
Muriate of potash	...	30 ,,
Saphos or Safaga	...	70 ,,
	Total	250 lb.

giving 27.6 nitrogen, 20.7 phosphoric acid and potash 15 lb. This does not differ widely in nutrient value from the previous mixture except in being more economical in potash, a change that the low crop justified. But for the same sum of money 400 lb. of this mixture could be bought, giving 44 lb. of nitrogen, 32.5 lb. of phosphoric acid and 24 lb. of potash. This is an increase of nearly 60 per cent in nitrogen, and the other constituents are also in suitable proportions.

In place of a single application, this was divided into two portions of 165 lb. at six months from pruning time and the remaining 235 lb. at 15 months from pruning. This programme satisfies all the general requirements of which I have been speaking.

We have not said the last word about tea manuring, and further refinements in practice can be confidently expected when our experimental scheme is expanded. What can I believe be as confidently predicted is that since the whole matter is being based on experimental evidence of known credibility, the changes will be progressive and not (as has more than once in past history been the case) retrograde and contradictory in their trend.

MEMORANDUM ON COMPOSTING WITH SPECIAL REFERENCE TO ESTATE AGRICULTURE.

PREPARED FOR SUBMISSION TO THE CENTRAL BOARD OF AGRICULTURE, NOVEMBER 17th, 1938.

T. EDEN

INTRODUCTION

At a meeting held on November 8th, 1934, the Central Board of Agriculture discussed the question of compost manufacture. The Board subsequently decided to review the question from time to time and the following memorandum is intended to provide a basis for discussion:—

At the meeting aforementioned, the questions which received most attention were (1) the potential sources of material; (2) the cost of manufacture; (3) the evidence real and alleged for the superiority of composting over present green manuring practices.

As the possibilities of composting were explored in subsequent months, it became evident that, apart from materials grown in tea, supplies of suitable material were ill-distributed particularly in the heart of the tea district.

> "The centre of the tea area in Ceylon is so closely planted that there is a scarcity of vegetable wastes except prunings and green manure." — (Howard, Roy. Soc. of Arts, Nov. 22, 1935).

Subsequent to his visit, Sir Albert Howard declared that the situation in up-country tea was difficult, though he did not regard it as hopeless.

This state of affairs led to an increasing use of green manures derived from tea land for composting and immediately raised the question of the economics of transporting material to and from the field and of the benefits that might accrue from composting materials rather than using them as green manures.

THE USE OF TEA PRUNING LEAF AND GREEN MANURES

The necessity for composting has been based on a number of theses.

> "Humus is a manufactured product with a carbon-nitrogen ratio of about 10 : 1 prepared from vegetable and animal wastes with a carbon-nitrogen ratio of about 33 to 1. . . . . Besides air, the organisms concerned in the manufacture also need water, a base to neutralise excessive acidity, and sufficient minerals particularly combined nitrogen. Their demands are almost identical with those of the roots of plants . . . . Hence the injurious effects on growth which almost invariably follow the addition of straw and, very frequently, of green manure to the Soil."—(Howard, Roy. Soc. of Arts, Nov. 22, 1935, p. 4.)

In so far as materials of wide carbon-nitrogen ratio are concerned this statement stands. It is obviously untenable with materials of carbon-nitrogen ratio approximating to that of manufactured humus. The investigations of the Tea Research Institute show that the carbon-nitrogen ratio of tea leaf and of green manure loppings are of the same order as that of 'humus' and that therefore on this score the latter part of the statement is irrelevant.—(Annual Report 1936, 39; 1937, 36).

> "In the High Range (of S. India) they used for composting any leguminous plants which might occur naturally in the jungle, but dadap cuttings, grown amongst the tea and having a carbon-nitrogen ratio of perhaps 15 to 1, they did not think worth while to compost. Such were put straight into the soil. They never took green stuff out of the tea area for composting since such was usually of a fine nature with a low carbon-nitrogen ratio." — Harler, The Manufactue of Compost in S. India, South Indian Assoc., Sept. 22, 1937.)

This statement agrees with the work of the Tea Research Institute. In discussion of this lecture Sir Albert Howard said:—

"It is very easy to poison land by putting in fresh green stuff." In so far as this is a reference to the nitrogen requirements, the case is met above, but it appears from other evidence to be based on the damaging effect of cacao pods fermenting below cacao trees. In this case large quantities of acetic acid are formed which are injurious, but this condition bears no relationship to practice with tea prunings and green manures on estates. Recent work on soil tilth indicates that a good soil structure is dependent in part on unhumified organic matter.—(Russell, E.W. Soil Structure, Imp. Bur. of Soil Science, Technical Communication 37, p. 33).

The practice of sweeping up tea pruning leaf as recommended in the Bagot process, coupled with the debatable assertion that artificial manuring could be discontinued, led to a deplorable state of affairs with regard to nutrition and soil erosion on estate properties, but the above conflicting views were largely resolved after Sir Albert Howard's visit to Ceylon in January, 1938.

He then recommended that no green manures or tea prunings should be removed from tea lands but that compost derived from waste land should be added to the prunings and loppings before burying *in situ*. This recommendation no longer ran counter to the Tea Research Institute's recommendations which had previously suggested the spreading of cattle bulk if available, before forking.—(Eden, *The Tea Quarterly*, Vol. 9, 1936, p. 13.)

THE PRESENT POSITION

Current practice seems to have moved away from the extreme position that was prevalent a year or more ago. More estates are abiding by the recommendation not to make compost out of 'internal' material, and estates which had abandoned artificial manuring programmes have seen the wisdom of modifying their views. Composting is settling down into a routine practice for the treatment of specially poor areas and for 'supplying' programmes. No estate within the knowledge of the Tea Research Institute is relying solely on compost for manurial treatment.* Concern has been expressed at the startling change induced in patna land whereby maana grass areas have been rapidly changed into less valuable lantana scrub by frequent cutting of grass for composting. There is room for more composting on smallholdings where green manure supplies are frequently not copious enough at a given moment for ordinary green manuring use. One sees quantities of unused and poor quality paddy straw on smallholdings which might be composted and the practice of burning the straw from the yala harvest appears to be wasteful in the extreme.

OTHER POINTS

Several of these have arisen which are of interest.

(1). *Mycorrhiza*.—This term refers to a specialised association of fungus and plant root which is found in many plants including tea, rubber and coconuts. On other crops this habit of growth has been found to be favoured by organic matter. In some cases this association has been found to be beneficial. The analogy in the case of tea remains at present only an interesting speculation worthy

* Since this memorandum was prepared our attention has been drawn to two estates using compost but no other manures.

of testing under adequately controlled conditions. Dr. Rayner, one of the foremost authorities on this subject, draws no distinction between the effect of compost and of green manure.

In her work on conifers, mycorrhizal stimulation was the result of compost application.—(Rayner. Forestry, Vol. 8, 1934, 96). In her studies of citrus fruits whose mycorrhizal habit is comparable with that of tea, the stimulative agency was green manure.—(Nature, Vol. 131, 1933, 399; Vol. 136, 1935, 516). Writing of tea Dr. Rayner says that she is "not actuated by a bias for or against green manuring or compost. It is a matter on which I have an open mind and on which I am not likely to form an opinion without intensive study of comparative material and the opportunity of observing growing plants in the field" . . . . . "Green manuring with a legume crop, *e.g.*, Crotalaria, growing profusely and forming nodules is clearly a special and very favourable case."*

(2). *The Use of Lime and Ash in Compost Making.*—Sir Albert Howard deprecates the use of lime as a base for neutralising acidity in compost heaps on the grounds of the harmful effect of lime on tea. In its place he advocates the use of wood ashes from lines. The distinction drawn between lime and wood ashes is a spurious one.—(Annual Report, 1928, 14; 1936, 36). Both have exactly the same effect. Alkalinity caused by any base is detrimental to tea. All samples of compost are higher in pH value than tea tolerates. Used in reasonable quantities the compost does not raise the pH value of the whole mass of soil to any appreciable extent. Within the last few months the Tea Research Institute has received a steady stream of specimens of basket plants which are either dead or moribund. In all cases the baskets were made up of either compost alone or half compost — half soil, or other high percentage of compost. In all cases the reaction of the soil was at fault and fully accounted for the symptoms. In all cases the cause was excessive use of compost.

(3). *The Value of Compost Analyses.*—Compost has a physical, a chemical and a biological effect and the question of which is predominant is frequently debated. It seems probable that the answer will vary according to local conditions. Chemical analysis can only evaluate roughly the chemical effect and to some extent the physical. That being so the question arises as to whether chemical analyses are worth while. From the point of view of computing the amount of common nutrients available to the plant the analyses are of limited value. The Tea Research Institute analysed a large number of composts in the early days of the controversy but discontinued the

* Private communication to the Tea Research Institute.

practice early in 1936 when they had served their purpose. Tea Research Institute analyses were confined to organic matter, humus, and nitrogen and no attempt was made to determine potash or phosphate, the reason being that these analyses were required merely as a method of detecting or confirming deficient manufacture. These analyses revealed that:—

(a). Excessive adulteration of compost with soil was taking place, with consequent low organic matter contents.

(b). That heavy losses of nitrogen were taking place during manufacture and that this was usually the case when highly nitrogenous residues such as green manures were exclusively used.—(Ann. Rept. 1935, 46; 1937, 36.)

In contradistinction to the view that the nutrient status of compost is of no importance, and that humus is all important may be set the following:—

> "Land can be tested for fertility by means of a complete artificial manure. If the soil is really fertile such a dressing will give no result because no limiting factor — in the shape of shortage of nitrogen, phosphorus or potash — exists. If the soil is not fertile a complete artificial will produce a result." — (Howard, J. Min. Agric. 1938, p. 433).

It is evident from this that the action of compost is in part that of normal nutrition since it satisfies the ordinary deficiencies of nitrogen. phosphorus and potash. Furthermore since, on the so-called infertile land, artificials produce an effect, it is equally evident that humus is not the limiting factor.

(4). *Disease Resistance.*—The claim is made that the use of humus will reduce and finally abolish disease.

> "In a number of cases, in tea and rubber in particular, very striking results followed closely on one dressing of compost applied at the rate of five tons per acre. There was a marked improvement in growth and also in resistance to insect pests such as red spider, *Tortrix* and mosquito blight (*Helopeltis*)."— (Howard, Empire Cotton Growing Review, XV, 1938, 215).
> "A fertile soil will enable the plant to carry out the synthesis of proteids and carbohydrates in the green leaf to perfection. In consequence, the toll now taken by fungus, insect and other diseases will at first shrink in volume and then be reduced to its normal insignificance." — (Howard, Empire Cotton Growing Review, XV, 1938, 310).

We may expect healthy cropping conditions to improve plant vigour. With respect to the claim for resistance against Tortrix, this statement has no foundation in fact.

(5) *Modification in Method of Manufacture of Compost.*—Sir Albert Howard recommends a modification designed by Mr. A. F. Bendall of Jagcherra Tea Estate, Sylhet which consists of constructing one or more channels at the bottom of the pit connected to flues at each end which communicate with the open air. The top of the channel is covered with an open work fret. The system is designed to promote more even aeration particularly at the lower depths. As far as our observations go it appears to be successful.

SOIL EROSION ON TEA ESTATES AND SOME SUGGESTIONS FOR ITS CONTROL.*

W. C. LESTER-SMITH

AGRICULTURAL OFFICER, SOIL CONSERVATION

Plantation agriculture may be defined as the cultivation of one or more types of crop plant in large compact communities in order to economize in the production and harvesting of the crops concerned. This type of agriculture involves the establishment of large areas under one main crop, and the application of labour and capital to it in such a way that production is rendered most profitable over the whole economic life of the crop.

With a perennial crop like tea, in which the period of lag between the application of capital to the crop and the sale of the finished product is often considerably longer than is the case with other crops, one of the primary necessities is to prolong the life of the crop so that the capital expended on it is spread over an economic period of profitable returns. There are two basic requirements of all perennial crops without which their life cannot be economically prolonged, and tea is no exception. These requirements are the conservation of the soil in which the plant grows, and the maintenance of its fertility.

* The text of an address delivered at a meeting of the Dimbula District Planters' Association on September 12th, 1938. Reprinted from *The Tropical Agriculturist*, 1938, Vol. XCI, No. 5.

The economic cultivation of any crop plant necessarily involves, from time to time, some disturbance of the soil in which that plant is growing; and this must inevitably lead to a greater or lesser degree of soil erosion. However small may be the amount of erosion which takes place, in time it will both reduce the fertility of the soil and increase the cost of production of the crop. The greater the slope of the land, the longer the length of the slope, and the more often the surface soil is cultivated or stirred, the greater will be this loss.

Owing to the varied environments in which tea is grown there are several types of erosion to which the surface soil of areas under tea is subjected. I propose to describe some of these, to comment on them briefly, and to suggest various ways in which the degree of erosion can be reduced.

Direct Rainfall Erosion.—This is due to the direct beating action of the individual raindrops on exposed areas of the surface soil. It is a form of erosion which occurs on areas planted with tea which are devoid of any high shade or ground cover, and when the tea plants themselves and any other existing low shade plants do not entirely cover the soil and intercept the rain. This form of erosion is perhaps most severe on soils which are kept clean weeded, which are loose and dry, which contain insufficient clay or humus to render them cohesive, and on areas which are almost denuded of all high and medium shade at the same time as the tea is pruned. In my opinion this form of erosion can be reduced by maintaining a rain-intercepting high or medium cover over the tea when it is pruned, by laying the prunings and by carrying out any artificial or green manuring that is done at this time, in counter-slope lines. Close planting will also serve to reduce this form of erosion.

Sheet Erosion.—This is the wide-spread removal of a very thin layer of soil, mainly the loose particles, from the surface of the land It is a form of erosion which is caused by surface run-off water. The amount of humus and soil moved is often considerable, and is increased by the steepness of the slope and by insufficient checks to the movement of this water. The greater part of the eroded soil is removed during the first hour or less of the run-off period result-from intensive falls of rain. The most efficacious preventives of this form of erosion are an extremely absorptive surface soil, numerous sponge-pits or trenches, and a low-growing ground cover. The plant (or combination of plants) which has none of the specific characters disadvantageous in a ground cover for tea, and which is easily established in different areas, has yet to be found. Until this has been accomplished, and until such a plant or mixture of plants has been proved to have no detrimental effect on the crop,

various makeshifts which will limit the movement of soil should be adopted. Various ground cover plants, such as *Oxalis* spp. and *Centella asiatica*, offer possibilities in this respect; but they all have one common disadvantage that they cannot be established everywhere and particularly where they are most needed. To what extent this is due to a reduction in the natural fertility of the soil resulting from past erosive action I cannot say, but I venture to think that in many cases it is primarily due to this cause. If this is so, two main ways of improving these conditions suggest themselves; firstly, by simulating at least a partial return to natural conditions by establishing an increased density of high and medium shade plants, and secondly, by reducing soil movement to a minimum in other ways. It appears to me that one of the cheapest and most effective methods of preventing sheet erosion on sloping land is to establish permanent hedges of some close-growing perennial plant. These hedges should be planted along contour lines at such vertical intervals as would best suit the slopes and soils concerned. If these hedges are once properly established and maintained they will reduce the length of the flow lines of surface run-off water, check its rate of flow, and effect the deposition of eroded soil along the upper sides of the contour hedges. In this way the forces of erosion will be directed along anti-erosive lines which will automatically terrace the land, reducing its slope, conserving its soil, limiting the movement of its humus surface-litter, and so raising the natural fertility of the soil.

Contour stone terracing can effect this equally well, when stone is available in sufficient quantity on the spot; but stone terraces suffer from the disability of having to be periodically heightened to prevent loss of soil from steep slopes on which soil movement continues to take place. Hedges of suitable perennial plants, however, grow up with the rising bank of arrested soil, tend to consolidate it, and cause less damage when breaches occur. The plant which I consider most useful for this purpose is the Sword plant (*Sansevieria quineensis*), while its indigenous relative, the Ceylon Bowstring Hemp (*Sansevieria zeylanica*), forms a fair substitute and is available in greater quantity.

Contour works of this type require to be co-ordinated with some system of drainage which will remove surplus run-off water and thus prevent its accumulating and breaching one or more of the contour works. Under the rainfall and other conditions which commonly prevail in Ceylon it is inevitable that a certain portion of the annual total rainfall eventually becomes surface run-off water. It is this fraction, however small it may be, resulting mainly from intensive falls of rain of short duration and restricted distribution, which causes the most severe erosion. Therefore unless contour works are

provided with some means of relief in the form of drains, they may be the cause of serious damage, if not on the area itself probably on that immediately below it. Contour drains naturally work best in conjunction with contour hedges and contour terraces, but existing estate drains can generally be utilized to serve a similar purpose, until such time as more up-to-date drainage systems can be constructed.

Contour hedges of the Sword plant have a particular value, I consider, for establishment in areas of tea which it is proposed to replant. For this purpose I would suggest that the contour hedges are planted at least a year before the old tea is removed, and that, at first, only those tea bushes which interfere with the establishment of the contour hedges are removed. The soil which is subsequently displaced and loosened by the removal of the remainder of the old tea plants will then be held up and protected from loss by the contour hedges. The land will tend to terrace itself, which will facilitate replanting and the subsequent plucking and cultivation of the area, and run-off and erosion will be reduced. Once the area is cleared, except for the contour hedges, a re-orientation of the drainage system of the area is facilitated, and more or less level contour drains can be constructed without the necessity for much pegging and lining. These drains should be sited on the lower side of the contour hedges and the spoil or excavated earth may be utilized for filling in old drains and for assisting the natural terracing of the land by spreading it along the upper sides of the contour hedges.

In connection with the replanting of the contour strips, I should like to correct an erroneous impression I appear to have given in a previous lecture I gave at Ratnapura (*Tropical Agriculturist*, June, 1938, Vol. 90, No. 6, page 363, last paragraph). I then said that contour planting did not appear to be suited to close-spaced row crops such as tea, etc., and I still hold this view. The slopes of the greater parts of the undulating land of Ceylon are either so small or so uneven as to render the large scale contour planting of close-spaced crops uneconomic, on account of the difficulties involved in their layout and management. To be more explicit I should say that I refer to strict contour planting, and not to those modified systems of contour planting which can be more correctly referred to as counter-slope planting.

Dry Wash.—This is a form of erosion which is mainly characteristic of steep stony slopes with a soil, the particles of which, when dry, are lacking in cohesion. They are the cultivated counterpart of areas which, I believe, in mountaineering parlance would be termed "scree." Dry wash, as its name implies, usually takes place in

areas which are subject to pronounced spells of dry weather, which are deficient in shade and ground cover, and have been so eroded in the past that any surface material worthy of the name of soil is conspicuous by its absence. The physical nature of the so-called surface soil, the slope of the land, and the sparseness of vegetative cover, are such that in dry periods, a spontaneous or induced downward movement of soil, soil-aggregates and stones, takes place on the more exposed slopes. It is due to evaporation of soil moisture and a low humus content causing a reduction in the cohesion between the particles which constitute the surface soil; and also to variations in the amount and position of soil moisture causing changes in the centre of balance of stones and soil-aggregates.

This form of erosion can be greatly reduced by permanent contour terraces, grass bunds, and hedges of almost any woody plant if sufficiently closely planted. As a temporary measure, low contour wattle fences, made of *Gliricidia* branches, etc., can be used with effect across areas of this type. High shade, low shade and ground cover plants, combined with green manuring, can also be used in addition, in order to increase the moisture-retaining capacity of the soil and its cohesiveness. The prevention of this form of erosion must, in any case, be based upon the prevention of soil movement and the revegetating of the area.

Bank Erosion.—The banks of roadsides, streams, gullies and drains often suffer severely from erosion as a result of their being devegetated, cut at too steep a slope, and unprovided with an adequate check to surface run-off water before it flows over the edge of the bank. A clean cut earth bank may look neat and tidy when it is kept free of weeds and all other vegetation, but to my mind, it cannot be considered either economic or stable unless it consists of hard rock-like material. Such banks are often cut so steep that no vegetation will grow on them, or they are periodically scraped and weeded to keep them clean. In this state they are perpetually exposed to the sun, the wind and the rain. The alternations of wet and dry conditions, cold and heat, and sometimes the percolation of sub-soil moisuture, upset their stability and cause cracks and fissures to appear in them which widen and increase in size in the course of time. Unchecked surface run-off water shoots over the top of the bank. If a splash-cushion or pavement is provided, the splash water wears away and undercuts the base of the bank; if no such provision is made, waterfall erosion pits and wears away the road, pathway, drain, or soil at the foot of the bank. Where the rush of surface run-off is checked by a grass edge at the top of the bank, the water flows down the exposed face of the bank causing fall-face erosion and gradually wears back the bank. An

even more pernicious form of undermining the face of devegetated banks is sometimes to be seen. This takes the form of scooping the earth or gravel out of hollows in the face of the bank, for the purpose of repairing and maintaining roads and paths.

The best method of stabilizing and preventing the erosion of the sides of banks, streams and drains is to slope them sufficiently to permit natural vegetation to grow or a desired type of vegetation to be established on them. A slope of from 45° to 60° is usually sufficient for the purpose of enabling a suitable type of vegetation to become established. Where available, Carpet grass (*Axonopus compressus*) is perhaps one of the best and tidiest bank-binding plants while the little white-flowered Australian Daisy (*Erigeron mucronatum*), often grown on banks and rockeries in gardens, provides an attractive alternative. *Indigofera endecaphylla* can also be sometimes used with advantage for this purpose.

Drain Bed-Scour.—In the case of graded main drains their beds often get badly scoured and pot-holed and their sides undercut to an extent which, on steep slopes or in readily eroded soil, rapidly converts them into ravines and gullies. Alternatively, narrow drains with straight sides, when cut in cohesive or erosion-resting soils, wear deeper and deeper as more easily eroded sub-soil strata are reached. Both these forms of erosion are not uncommon; they may develop to such a degree that the height of the water table of the land on each side is permanently lowered, so that during short dry periods, artificial drought conditions for the crop are induced.

The remedy lies in sloping the sides of all drains, reducing their depth, and retarding the rate of flow of water by vegetating them, and constructing in them check-dams, locks and blocks, and reverse-slope steps. It has to be realised that apart from such factors as volume of water, gradient, retard effect, etc., the rate of flow of water in drains is largely governed by its depth; thus, the deeper and narrower a drain the greater the rate of flow of water in it, and so the greater its erosive power.

A word of warning is perhaps necessary here as regards the construction in drains, of locks, pits and reverse-slope steps in areas at low-elevations where malaria is endemic. Such water-retaining compartments provide suitable breeding places, particularly when insufficiently shaded, for the malaria-carrying mosquito *Anopheles culicifacies*. In malarial areas, therefore, it should be a rigid rule that all such water-holding silt-pits, locks and step-angles should be converted into, and properly maintained as, sponge-pits, sponge-trenches, and sponge-cushions, by keeping them at least half to three-quarters full of dead weeds, cut grass and other cut vegetation

which is absorbent and readily decayable humus-forming material. This will reduce the length of time water stands in these places, assists its percolation into the soil and make any such water less acceptable for breeding purposes. A good growth of suitable vegetation should be permanently maintained in, and on the sides of banks of, all such drains so as to keep them effectively shaded.

DISCUSSION

In answer to a question by Mr. R. C. O. Hill as to the effect of "dirty weeding" on yield, **Dr. Eden** replied that there was no doubt that the practice of selective weeding, for a period of time, would tend to reduce crop. That, at any rate, was their finding on the effects of selective weeding at St. Coombs, but how long that state of affairs would go on he could not say.

Already there were signs in their own yields that the process of crop reduction had more or less touched rock bottom and that possibly in some time to come the drop to 10 per cent. on normal crop would become less.

Taking into consideration even a period of a number of years when there would be very much less crop, he thought, some form of selective weeding would definitely have to be carried on on up-country estates in order to stop soil erosion.

The reason for that opinion was that he felt perfectly confident that although erosion took place at a rate which could not be easily measured, it was by far the most vital cause of permanent loss of crop.

St. Coombs experiments also showed that if one happened to have a selective weeded area, loss of crop in that area could be very simply put right by an adjustment of the manurial supply.

He did not wish to be dogmatic but he had formed the opinion that the extra cost of manurial adjustment would be very much less than the cost of replanting and re-supplying which would otherwise become necessary as a result of loss of bushes due to a deficient root system resulting from soil erosion on a large scale.

He thought that any question as to the temporary loss of yield owing to "dirty weeding" should not stand in the way of an effective control of soil erosion by some sort of ground cover.

It was 8 years since the Soil Erosion Committee had made its report. He had been privileged to attend quite a number of that Committee's meetings when the local Planters' Associations were giving evidence, and he had noted at that time that practically everybody had a good word to say about *Oxalis*, which they thought to be the planters' friend from the point of view of soil erosion.

One had become inured to the idea of *Oxalis* because it was something one could not get rid of. Although he would not like to say that selective weeding should be done in the same way in every place, he would like to suggest that when they got a little more used to selective weeding, they would regard it in the same way as *Oxalis*.

Mr. L. B. Green said that Mr. Lester-Smith seemed to indicate that if the soil surface was disturbed soil erosion would be greater than if it were not disturbed. His experience on tea estates, however, was that, having to cultivate them once a year or so, the land which was well forked showed far less erosion than land which was not forked.

Mr. Lester-Smith replied that it all depended on the state of the soil when rain hit it and the intensity of the rainfall. Heavy showers took away a good deal of soil from sloping land. On the other hand if the land was very much broken up and the surface very rough there would be greater absorption of rain. What had to be taken into consideration was the rate of percolation of water into the sub-soil.

Replying to Mr. Green, Mr. Lester-Smith said he saw no reason to believe that the Sword plant was in any way injurious to tea. He quite agreed that *Centella asiatica* had a very closely-matted surface which, from the point of view of tea cultivation, might be regarded by some as undesirable, but that trouble could be easily got over by forking. *Centella asiatica* was not a climber.

Referring to the link between soil erosion and soil disturbance, **Mr. Jones** said he distinctly remembered estates where between each row of tea there was quite a big drop in soil and a great deal of root exposure. That had now been put to right by forking, introduction of green manures and cultivation generally. The difference between now and 30 years ago was that their tea fields were far better off now from the point of view of protection from soil erosion.

Mr. Baillie-Hamilton recalled his observations of 40 or more years ago to confirm Mr. Jones' contention that today Up-country estates suffered far less from soil erosion and had more humus.

Dr. Norris said that the present decrease in soil erosion might partly be due to a greater depth of cultivation. A lot of damage had no doubt been due to inefficient cultivation. If cultivation was really efficient and got down to the lower layers and there was a greater breaking up of these layers, efficient percolation took place and soil erosion would be reduced.

Dr. Eden said he very thoroughly agreed with all the findings which Mr. Lester-Smith had so ably put forward. He was particularly interested to find that the discussion had turned on to the difficult point of the effect of cultivation on soil erosion.

When some years ago it had fallen to his lot to read all the literature available on soil erosion, it was on that one point that he had found evidence to

be most conflicting. As a matter of fact they were gradually getting results which threw a little more light on the point as it affected tea.

There was no doubt that on a field which was recently cultivated to a good depth and in a rough condition, the absorbent power of the soil was able to deal very efficiently even with very heavy showers of rain.

But recently he had found that the compression of the soil by the ordinary daily, weekly and monthly treading by the labour produced a sort of false pan in the top reaches of the soil and that compression regulated the absorption throughout the whole depth. That was to say there might be a top soil pan of three inches, below which was quite a loose layer which remained in that condition for many months after cultivation.

He had a plot on St. Coombs which had not been touched for over two years since it was cultivated; it had not been trodden upon, and the absorption of moisture at present was excellent. Within a few weeks of cultivation of soil the treading pan was formed and that pan caused less absorption of moisture which he felt perfectly certain was responsible for 75 per cent. of the erosion in tea. For that reason ground cover or any other thing that added to the humus was obviously a good thing.

What had happened in times past was they did lose the soil, but as it was not cultivated they got down to what was known as an erosion pavement and that erosion pavement of small stones eventually became a small check. Even that erosion pavement would not prevent a gully which would form in the soil which was not protected by any other means.

With regard to *Centella asiatica* he wished to say one thing lest at some future time there should be a conflict of advice as between the Tea Research Institute and the Department of Agriculture.

Centella asiatica was a very excellent cover to be used where nothing else was possible. From observations made there was no doubt that it had a very marked competitive effect, and for that reason he personally would not advise its indiscriminate use.

He would, however, say that where they had sides of drains or extra steep slopes on which nothing else would grow he would be prepared to use *Centella asiatica*. Where there were no such steep slopes he would certainly first try to cultivate something which had a less extensive root system to compete with tea.

TEA CONSUMPTION IN INDIA.

Mr. P. J. Griffiths, C.I.E., M.L.A., Chairman of the Indian Tea Market Expansion Board, reviews the progress made in building up a future for the tea industry in India in the jubilee number of *Capital* of Calcutta.

After recalling that as far back as 1893 — considerably before the possibilities of systematic propaganda had been realised in the world at large — tea producers in India taxed themselves to provide funds for propaganda for tea. Mr. Griffiths continues:—

In 1916, when serious attention first began to be paid to work in India, the Indian Tea Cess Committee, which has since been succeeded by the Indian Tea Market Expansion Board, concentrated upon the establishment of tea shops at railway station stalls, ghats, and other places where people habitually congregate. At this stage little or nothing was done to induce people to drink tea, for it was first necessary to ensure that tea should be available for those who might wish to drink it. By 1930 considerable progress had been made in this direction, and it can now be said that a cup of tea can be procured at any important railway station in India, and that in most important towns of India the supply of tea is equal to demand. In 1930, therefore, the Committee began to turn its attention to direct propaganda, and, in view of the fact that about 90 per cent. of the population of India lives in the villages, it was decided that the methods of propaganda employed must be those suitable for illiterate village folk.

The first problem is to persuade the villager to taste tea at all — and those who have experience of the extreme conservatism of the ordinary Indian villager in everything that affects his daily life will realise that it is no easy task; for this purpose demonstration tables have been set up in all the important towns and large villages in selected areas and at these demonstration tables a free cup of tea is given away to everybody who will drink it. It is an amusing sight to watch the reaction of the villager who for the first time is persuaded to taste tea at one of the stalls. His first reaction is frequently one of extreme suspicion, based apparently on the principle that tea cannot be a good thing, otherwise people would not want to give it away; in some cases, too, there is a suspicion that in

drinking an unknown beverage like tea the consumer may be unconsciously violating some rule of caste. At this stage considerable tact is required on the part of the demonstrator and it is always an advantage when the demonstrator himself belongs to the same caste or community as those amongst whom he is working.

To give away free cups of tea sounds simple enough, but, in fact, the process involves a great deal of supervision and constant attention to hygienic and other factors. In those parts of the country where people will drink from earthenware vessels, every recipient of a free cup of tea is given his own cup, which is thrown away after use, but this method cannot be applied everywhere, as there are areas where people will not drink from earthenware vessels. Then again the taste for sweetness varies greatly from one part of the country to another. Before propaganda can be carried out in any area, it is necessary to discover exactly how much milk and sugar will make tea palatable to the rural public. Provided sufficient attention is given to this factor, a man who has drunk a cup of tea at one of the demonstration stalls will, as a rule, come back sooner or later for a second cup, and, if the site has been well chosen in a place likely to be regularly visited by those concerned, it is usually only a question of time before the villager makes a regular habit of visiting the stall.

It is not sufficient, however, to give away free tea to those who come for it, for, apart from any considerations, such methods do not touch a considerable proportion of the womenfolk of the country. When a man has been given a cup of tea an attempt is therefore made to sell him a nice packet of tea which contains sufficient to make five cups of good tea. One of the demonstrators' tasks during his distribution of free tea is to explain the method of making tea, and a skilful demonstrator will always manage to collect a crowd round his stall before he makes the next brew. While he is doing this — and, indeed throughout the demonstration — it is up to the demonstrator to point out the cheapness and the valuable qualities of the beverage. This work of demonstration is now proceeding on a very large scale, and at the present moment some four million free cups of tea are distributed monthly and about one million pice packets per month are sold at the demonstration tables. It is difficult to exaggerate the value of the sale of these pice packets, for, purchased as they are in the towns, they are then taken to the village homes of the purchaser where, no doubt they are sampled in due course by the women of the household. This kind of work is supplemented by demonstrations at *melas* and by cinema shows, but the demonstration table remains and must remain the keystone of the Indian Tea Market Expansion Board amongst the villagers.

The approach to the middle classes and the well-to-do people presents a much more difficult problem, for their social status will not permit them to come to the demonstration tables. In Britain the corresponding class is approached by means of house-to-house canvassing, and in some areas it is proposed to make attempts along those lines in India; it is, however, difficult to get canvassers of the right kind in India who would be suitable for this kind of work, and there exists a strong feeling that going from house-to-house canvassing is lowering to the position and dignity of the canvasser. Then, too, the purdah system makes it, in many cases, impossible for a male canvasser to get into effective contact with the ladies of various households. In theory, this difficulty could be overcome by employment of lady canvassers, but in practice, it is difficult, if not impossible, to get such canvassers. Women who are uneducated would not be suitable for the work, and educated ladies, under present conditions of Indian social life, are, except in rare cases, not available for this kind of work. The approach of the Indian Tea Market Expansion Board to the respectable classes has therefore of necessity been largely confined to Press propaganda.

It is always difficult to isolate causes and it is impossible to say how much of the increased consumption of tea in recent years is due to the work of the Indian Tea Market Expansion Board, but the fact remains that simultaneously with the growth of that work there has been a phenomenal development in tea consumption. The science of statistics in India is in its infancy and the available figures must be regarded as very rough approximations, but such figures as are available show that consumption of tea in India has risen from 18 million pounds in the year 1902-3 (the year before the inauguration of the Tea Cess Committee) to about 90 million pounds per annum at the present time. Even this 90 million pounds, however, only represents a consumption of less than ¼ lb. per head throughout India, as compared with the figure of nearly 11 lb. per head in the United Kingdom, so that it is quite clear that there is ample scope for still further developing the work of the Board.

Considerable controversy has from time to time risen with regard to the work of the International Tea Market Expansion Board in U. S. A. and it is urged by some that the work should be discontinued and money thus set free for expenditure in India instead. The exponents of this view appear to overlook certain important considerations. Great as is the value of propaganda in India, it is important to bear in mind that the Indian demand is mainly for cheap teas, the sale price of which in some cases is even less than the cost of production. Although the development of this demand, which by expanding sales will, in course of time, lower the cost of

production per pound, is important, nevertheless it cannot take the place of the development of markets for high-priced teas.

Nor can we rely on the U. K. for an indefinite period to take all the high-priced tea that India can produce. In trade propaganda it is necessary to take a very long view and such a view suggests that according to all statistical evidence we are approaching a period of rapid decline in the population of the U. K. There seems little reason for doubt that in fifty years' time the population of Great Britain will be considerably less than it is now, and it is therefore essential to find some market to replace that which will be lost as a result of the decline in the population of Great Britain. Under such circumstances it would be sheer madness to ignore the possibilities of developing the American markets. The high standard of living in that country and its vast population would make it a very great potential market for tea if the tea-drinking habit could be developed, and the International Tea Market Expansion Board would be completely failing in its duty to the industry if it neglected to carry out propaganda in the U. S. A. Moreover, whatever may have been the case in the past, reports are now being received from every hand to the effect that tea propaganda in the U. S. A. is beginning to have its effect and the strongest possible support to that view is given by the fact that the tea trade in America has begun to spend money on propaganda along lines similar to those carried out by the Board. It is too early to prophesy, but it may be said with confidence that the present signs and reports are such as to provide the fullest possible justification for the continuance of propaganda in the U. S. A. by the International Tea Market Expansion Board.

It is not possible in this article to discuss the other aspects of the organisation of the tea industry, and the justification for having devoted so large a proportion of this article to consideration of that one aspect represented by the Indian Tea Market Expansion Board must be found in the fact that the work of the Board is the corner-stone upon which the industry as a whole must rest.

NOTES

Propagation of Tea by Single Internode Cuttings.—The type of cuttings employed consists of a leaf and the stem beneath it down to a point a little above the junction of the next leaf below with the stem. If a suitable stem is cut just above each leaf with a *sharp* knife such cuttings are readily obtained. The cut should not be very oblique. Very young leaves are undesirable as they wilt and rot; old leaves tend to drop off either during propagation or too early after planting out in the field. The maintenance of an adequate leaf surface is of importance and it is therefore very desirable to pay attention to this point. Fully mature leaves on green or *lightly* reddened stems are the best, and it is no disadvantage if the bud on the axil of the leaf has started to grow a little. If much growth has been produced, however, the tender shoot should be pinched back to the first fish leaf from the stem before planting.

The peatmoss is lightly beaten to break up lumps and moistened for several days prior to planting, so that it is thoroughly moist but not sodden. About six inches is a suitable depth in a box or bed; if in a box, the cuttings may be covered with advantage by a sheet of glass. In any case arrangements should be made to prevent direct sunlight or even bright light reaching the cuttings. It is for this reason that the back of an airy verandah or similar structure is suitable. The cuttings should be lightly moistened down every evening, or more frequently in very dry weather, *but the peatmoss must not be rendered sodden.*

The best time of the year in the south-west zone is just before the break of the South-West Monsoon. By its end the cuttings will have developed young roots and may be gradually hardened off prior to planting in the North-East Monsoon. Five to six months should be allowed for rooting and hardening off, when the plants can be lifted with a ball of peatmoss attached and planted either in baskets or bamboo pots, in a nursery for the production of stumps, or direct into a prepared plot. If the latter step is taken, the services of an experienced garden cooly are necessary in the early stages of establishment to prevent sun scorch, etc., as unless care is taken considerable loss may occur from this cause. The use of a heavy shade of grevillea foliage thinned daily after the first fortnight obviates this. With rather less satisfactory results, cuttings may be rooted under shades of hessian or manna grass supported on wire netting

Once established, cuttings appear to grow equally as well as seedlings of the same age but different clones exhibit very marked differences in ease and speed of rooting. These differences reach their full expression when sand is used as a rooting medium, but are less obvious, though still marked, when peatmoss is used.

Several experiments have been carried out upon propagation by cuttings during the year in addition to routine propagation of selected bushes. In the Annual Report for 1937 it was noted that peatmoss was apparently proving distinctly more satisfactory than sand, and an experiment was therefore set up to compare the rooting of seven clones in sand and in peatmoss, both in the presence of and in the absence of phenylacetic acid in solid form exposed within the propagation box.

A total of 1,020 cuttings were used.

The sand was a coarse white silica grit obtained from decomposed quartzite in the Madulsima district.

The mean results after six months were as follows:—

	Peatmoss	Grit	Ph. Acid.	Nil
Percentage alive	88.9	81.8	83.8	86.8
Percentage rooted	86.8	51.5	67.3	71.0
Percentage of survivors rooted	97.6	61.0	77.8	80.8

The presence of phenylacetic acid in the boxes had no significant effect and the tentative conclusion mentioned in the Annual Report for 1937 must, therefore, be abandoned. Peatmoss as compared to sand did not affect the percentage of cuttings alive after six months, but did significantly increase the percentage of cuttings rooting in that period, whether expressed on the basis of the number of original cuttings or of the number surviving alive. The differences were not confined to the number rooting — the larger and more vigorous root systems formed in peatmoss were particularly noteworthy. Measurements were not made, however, as the clonal material was required for planting out.

Minor Elements in Relation to Plant Growth.—When considering the mineral requirements of crops many persons are inclined to think only in terms of phosphoric acid, potash and lime. It has, however, long been known that plants require in small quantities a much wider range of mineral substances.

The composition of the ash (or mineral material) of plants is, in fact, very complex and variable and almost all the elements have been found in the ash of different species. In addition to phosphorus, potash and calcium, the following elements appear, however, to be of most general importance: magnesium, iron, sulphur, zinc, boron, manganese, silica, chromium and copper.

In the absence of the necessary quantity of any of these materials growth may either cease or be abnormal in some way and more recently certain well-defined diseases of plants have been definitely traced to a deficiency of one of these materials.

On the other hand, excessive amounts may be toxic to the plant and lead to equally serious symptoms. In other cases again, though the effect of these substances may not be noticeable in the plant, the nutritive value of the crop to animals may be impaired. Thus in South Dakota soils which are rich in selenium, the crop produced may be toxic to stock though the plants showed no ill-effect.

It is evident, therefore, that the question of a proper balance of these minor elements may be of considerable importance in crop production and, as has already been mentioned, certain diseases of plants, the origin of which was previously obscure, has now been traced to the absence, or in other cases to the presence of excessive quantities of such elements.

Up till relatively recently the question of the part which these substances may play in the growth of tea has not received much consideration. Generally speaking there is less likelihood, perhaps, of a deficiency of most of these materials in tea cultivation since tea soils are invariably strongly acid in character whereas deficiencies of boron, zinc, manganese and other similar elements are more likely to occur under alkaline conditions.

The Yellows Disease of tea in Nyasaland, which somewhat resembles Witches Broom, has been found, however, to be due to a deficiency of sulphur, while certain difficulties which have been encountered in obtaining a satisfactory fermentation of the leaf in various districts in East Africa are due, it has been claimed, to a lack of copper.

It would be unwise, therefore, to assume that these minor elements are of no importance in relation to tea and in view of certain diseases now under investigation a fuller knowledge of their function would be of assistance.

Tea Stocks.—The stocks of tea in London which represent approximately 90 per cent of the United Kingdom total, amounted at

the end of November to 207.6 million pounds against 177 millions at the same date in 1937 and 215.3 in 1936.

Foreign Tea Imports.—The imports of China and Japanese tea into the United Kingdom during the first ten months of 1937 at 11.3 million pounds are lower by 7.3 millions in comparison with the previous year's figures over the same period. Consumption of these teas over the same period is nearly 10 million pounds less.

Cockroaches.—The following powder has been found extremely effective when dusted into cracks or blown behind boards etc. where cockroaches hide during the day:—

Abol Powder Ant Killer	...	$\frac{1}{4}$
Pyrethrum Powder	...	$\frac{1}{4}$
Powdered Borax	...	$\frac{1}{2}$

The Abol Powder is obtainable from Abol Ltd., Paddock Wood, Kent, England. When used for blowing, the mixture should first be sifted to remove any large particles.

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 22-12-38.

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held in the Committee Room of the Ceylon Chamber of Commerce on Thursday, December 22nd, 1938, at 2-30 p.m.

Present.—Mr. James Forbes, Jnr. (Chairman), the Hon'ble the Financial Secretary, (Mr. H. J. Huxham), the Acting Director of Agriculture (Mr. F. P. Jepson), the Chairman, Planters' Association of Ceylon (Mr. R. C. Scott), the Chairman, Ceylon Estates Proprietary Association (Mr. R. J. Hartley), Major J. W. Oldfield, C.M.G., O.B.E., M.C., Messrs. I. L. Cameron, J. D. Hoare, J. C. Kelly, T. B. Panabokke and Dr. R. V. Norris (Director and Secretary). Messrs. H. Tonks (Visiting Agent) and J. A. Rogers (Superintendent) were present by invitation.

Absent.—Mr. R. G. Coombe and Mr. S. F. H. Perera.

1. The Notice convening the meeting was read.

A letter was tabled from Mr. R. G. Coombe expressing regret at inability to attend.

2. The Minutes of the Meeting of the Board held on 28th October, 1938 were confirmed.

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

Reported that Mr. J. C. Kelly had resumed his seat on the Board on his return from leave, relieving Mr. K. W. Taylor.

A vote of thanks to Mr. Taylor for his services was recorded.

The Chairman welcomed Mr. F. P. Jepson who was acting as Director of Agriculture in place of Mr. E. Rodrigo who had gone on leave.

4. FINANCE

(a). The Institute's Accounts to November 30th, 1938 were approved without comment.

(b). *Adjustments of Votes.*—Various adjustments of sub-votes sanctioned by the Chairman under Rule 19(e) were confirmed by the Board.

The following additional votes were approved:—

RESEARCH REVENUE ACCOUNT

General Services.—Vote 57. Water Supply Rs. 350.

Miscellaneous.—Vote 71. Medical Scheme Junior Staff. Rs. 70.

Vote 72. Medical Fees Sub-Staff Rs. 140.

ESTATE WORKING ACCOUNT

Vote 63. Machinery Upkeep Rs. 275.

Vote 22. Watchers Rs. 175.

(c). *Investments.*—Reported that the Seal of the Board had been affixed to the transfer certificates and interest notices relating to the recent purchase of 4 per cent Funding Loan as sanctioned by the Board at the last meeting.

(d). *T. R. I. Cess.*—Reported that the Ordinance to provide for the continuance of the Cess at 14 cents per 100 lbs. tea exported until 31st December, 1943, was passed by the State Council without division on the 14th December, 1939.

The Chairman expressed his indebtedness to the Financial Secretary, Major Oldfield and Mr. Gaddum for their assistance in this matter.

(e). *Estimates 1939.*—The Chairman said these had been circulated to the Board and had been before the Finance Sub-Committee that morning.

A. *Working Account.*—It was noted that the estimates were based on a crop of 185,000 lbs. a check-roll average of 54 cents, and a plucking average of 45 cents.

The Board approved that General Charges be divided between Working Account and Capital in the proportion of 83½ per cent to Working Account and 16½ per cent to Capital.

The Board then approved the estimate for estate working account amounting to Rs. 93,870 or 50.75 cents per pound.

B. *Estate Capital Account.*—In reply to the Financial Secretary who referred to the cost of bringing immature areas into bearing, the Chairman explained that the proportion of General Charges debitable to Capital would be reduced in the following year. Figures would then be prepared giving the cost of clearings.

The Estimate for Estate Capital Expenditure amounting to Rs. 15,371 was approved.

Research Revenue Expenditure.—It was noted that provision was made under votes 2 and 39 for the Chairman and Director to visit North-East India and Tocklai Experimental Station during the year.

The Board approved the estimate of Rs. 240,528 under Research Revenue Account.

The Board approved the revised estimate of Rs. 15,875 under Research Capital Account.

The Board also sanctioned the carrying forward to 1939 account of any unexpended balance of the votes for the Guest House and Equipment.

5. ST. COOMBS ESTATE

The Chairman said the Visiting Agent's Report for December had only just been received and would come before the Board at the next Meeting after consideration by the Experimental Committee.

6. RULES FOR GUEST HOUSE

The Board considered the draft rules for the use of the Guest House as recommended by the Finance Committee. After minor modifications in wording, the Board approved these rules with the addition of a rule relating to recoveries for breakages.

In reply to Mr. Hoare, the Chairman said a Guest House account would be maintained.

He also informed the Board that the Guest House should be ready for occupation in February.

7. T. R. I. CONFERENCE

The Board approved the date of the Conference being changed to 13th and 14th February to enable Sir John Russell, F.R.S. to attend.

It was also agreed to hold the meeting on the 13th at the Dimbula Athletic and Cricket Club, Radella.

The draft programme for the Conference was approved.

8. RESEARCH ON CHEMISTRY OF TEA

The Director reported that information had been received from the Ceylon Association in London that the Netherlands East Indies Authorities had agreed to contribute to the Joint Research Fund for 5 years. It was hoped a contribution would also be obtained from the South Indian Tea Association.

Mr. Lamb was in touch with Dr. Lampitt in regard to the technical aspects of the scheme.

9. ANY OTHER BUSINESS

(i). The Board approved of the Director accepting an invitation to broadcast to schools on the 9th March on the work of the Institute.

(ii). A vote of thanks was accorded to the Ceylon Chamber of Commerce for the use of their room for meetings of the Board.

The Meeting then terminated with a vote of thanks to the Chair.

ROLAND V. NORRIS,
Secretary.

NOTICES.

The Institute's Laboratories and Offices are situated at St. Coombs, Talawakelle, and all applications and enquiries should be addressed to the Director, Tea Research Institute, St. Coombs, Talawakelle.

Specimens and other consignments sent by rail should be forwarded to Talawakelle Station c/o Messrs. Hemachandra & Co., Forwarding Agents.

Visitors' Day.—The *last* Wednesday in each month has been set aside as Visitors' Day at St. Coombs Estate and also at the T. R. I Sub-Station, Gonakelle Estate, Passara, when it is hoped anyone interested will visit the Stations.

Visitors at other times are welcomed, but it is requested that an appointment be made if possible.

ROLAND V. NORRIS,

Director.

The Tea Research Institute of Ceylon.

BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon :—

(1) Mr. R. G. Coombe

(2) Mr. Jas. Forbes (Jnr.), (Chairman)

(3) Mr. J. D. Hoare

(B) Representing the Ceylon Estates Proprietary Association :—

(4) Major J. W. Oldfield, C.M.G., O.B.E., M.C.

(5) Mr. I. L. Cameron

(6) Mr. J. C. Kelly

(C) Representing the Low-Country Products' Association :—

(7) Mr. S. F. H. Perera

(D) Representing the Small-Holders :—

(8) Mr. T. B. Panabokke

(E) Ex-Officio Members :—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture

(11) The Chairman, Planters' Association of Ceylon

(12) The Chairman, Ceylon Estates Proprietary Association

Secretary, Roland V. Norris, D.Sc., St. Coombs, Talawakelle.

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The publications of the Tea Research Institute will be sent, free of charge, to Superintendents of Ceylon tea estates, over 10 acres in extent, and to Estate Agencies dealing with Ceylon tea, if they register their names and addresses with the *Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.*

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.

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